RTL8191SE

SINGLE-CHIP IEEE 802.11b/g/n WLAN CONTROLLER with PCI EXPRESS™ INTERFACE

DATASHEET

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USING THIS DOCUMENT

This document is intended for the software engineer's reference and provides detailed programming information.

Though every effort has been made to ensure that this document is current and accurate, more information may have become available subsequent to the production of this guide. In that event, please contact your Realtek representative for additional information that may help in the development process.

REVISION HISTORY

Revision	Release Date	Summary
0.4	2008/11/26	Preliminary release.

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1. General Description

The Realtek RTL8191SE is a highly integrated single-chip MIMO wireless LAN (WLAN) solution for the wireless high throughput 802.11n draft specification. It combines a MAC, a 1T2R capable baseband, and RF in a single chip. The RTL8191SE provides complete solution for a high throughput performance wireless client.

The RTL8191SE baseband implements multiple input, multiple output (MIMO) orthogonal frequency division multiplexing (OFDM) with 1 transmit and 2 receive paths and is compatible with 802.11n Draft specification 2.0. Other features include one spatial streams transmission, up to two spatial streams reception, short guard interval (GI) of 400ns, spatial spreading, and transmission over 20 MHz and 40 MHz bandwidth. At the receiver, extended range and good minimum sensitivity is achieved by having receiver diversity up to 2 antennas.

For legacy compatibility, direct sequence spread spectrum (DSSS), complementary code keying (CCK) and OFDM baseband processing are included to support all IEEE 802.11b and 802.11g data rates. Differential phase shift keying modulation schemes, DBPSK and DQPSK with data scrambling capability, are available along with complementary code keying to provide the data rates of 1, 2, 5.5 and 11Mbps with long or short preamble. The high speed FFT/IFFT paths, combined with BPSK, QPSK, 16QAM, and 64QAM modulation of the individual subcarriers and rate compatible punctured convolutional coding with coding rate of 1/2, 2/3, 3/4, and 5/6, provides the maximum data rate of 54 Mbps and 300 Mbps for IEEE 802.11g and 802.11n MIMO OFDM respectively.

The RTL8191SE builds in an enhanced signal detector, an adaptive frequency domain equalizer, and a soft-decision Viterbi decoder to alleviate the severe multi-path effects and mutual interference in the reception of multiple streams. For better detection quality, receive diversity with maximal-ratio-combine (MRC) applying up to 2 receive paths are implemented. Robust interference detection and suppression are provided to protect against bluetooth, cordless phone, and microwave oven. Receive vector diversity for multi-stream application is implemented for efficient utilization of MIMO channel. Efficient IQ-imbalance, DC offset, phase noise, frequency offset and timing offset compensations are provided for the radio frequency front-end impairments. Selectable digital transmit and receiver FIR filters are provided to meet the requirement of transmit spectrum mask and to reject the adjacent channel interference, respectively.

The RTL8191SE supports fast receiver automatic gain control (AGC) with synchronous and asynchronous control loops among antennas, antenna diversity functions, and adaptive transmit power control function to obtain the better performance in the analog portions of the transceiver.

The RTL8191SE MAC supports 802.11e for multimedia applications, 802.11i for security, and 802.11n for enhanced MAC protocol efficiency. Using packet aggregation techniques such as A-MPDU with BA and A-MSDU, protocol efficiency is significantly improved. Power saving mechanisms such as U-APSD, APSD, and MIMO power saving reduces the power wasted during idle time, and compensates for the extra power required to transmit MIMO OFDM. The RTL8191SE provides simple legacy and 20Mhz/40Mhz co-existence mechanisms to ensure backward and network compatibility.

2. General Features

General

64-pin QFN

CMOS MAC, Baseband MIMO PHY, and RF Single Chip for IEEE 802.11b/g/n compatible WLAN

Complete 802.11n MIMO solution for 2.4GHz band

1x2 MIMO technology for extended reception robustness and exceptional throughput

Maximum Tx/Rx PHY data rate up to 75M/150Mbps using 20Mhz bandwidth, 150M/300Mbps using 40Mhz bandwidth

Compatible with 802.11n draft 2.0 specification

Backward compatible with 802.11b/g devices while operating at 802.11n data rates

Host Interface

Complies with PCI Express™ Base Specification Revision 1.1

Standards supported

802.11e QoS Enhancement (WMM, WMM-SA Client mode)

802.11h TPC, Spectrum Measurement

802.11k Radio Resource Measurement

802.11i (WPA, WPA2). Open, shared key, and pair-wise key authentication services

Cisco Compatible Extensions (CCX) for WLAN devices

MAC Features

Frame aggregation increase MAC efficiency (A-MSDU, A-MPDU)

Low latency Immediate High-Throughput Block Acknowledgement (HT-BA)

Long NAV for media reservation with CF-End for NAV release

PHY-level spoofing to enhance legacy compatibility

MIMO power saving mechanism

Channel management and co-existence

Multiple BSSID feature allowing RTL8191SE to assume multiple MAC identity when used as wireless bridge

Supports Wake-On-WLAN via Magic Packet and wake-up frame

TXOP SIFS bursting guarantees multimedia bandwidth

Peripheral Interface

- General Purpose Input/Output (8 pins)

- 4-wire EEPROM control interface (93C46)
- Configurable LED pins (2)
- Configurable Bluetooth Coexistence Interface

PHY Features

IEEE 802.11n draft 2.0 MIMO OFDM

- 1 transmit and 2 receive paths (1T2R).
- 20MHz and 40MHz bandwidth transmission.
- Short Guard Interval (400ns).

DSSS with DBPSK and DQPSK, CCK modulations with long and short preamble.

OFDM with BPSK, QPSK, 16QAM, and 64QAM modulations. Convolutional coding rate: 1/2, 2/3, 3/4, and 5/6.

Maximum data rate 54Mbps in 802.11g and 300Mbps in 802.11n.

OFDM receive diversity with MRC using up to 2 receive paths. Switch diversity used for DSSS/CCK.

Hardware antenna diversity.

Selectable digital transmit and receiver FIR filters

Programmable scaling in transmitter and receiver to trade quantization noise against increasing probability of clipping.

Fast receiver automatic gain control (AGC).

On-chip ADC and DAC**.**

3. Application Diagram

3.1. Single band 11n application

You can use RTL8191SE (11n 1x2 MAC/BB/RF) to support the flexible single band MIMO (1x1/1x2) solution upon your various requirement.

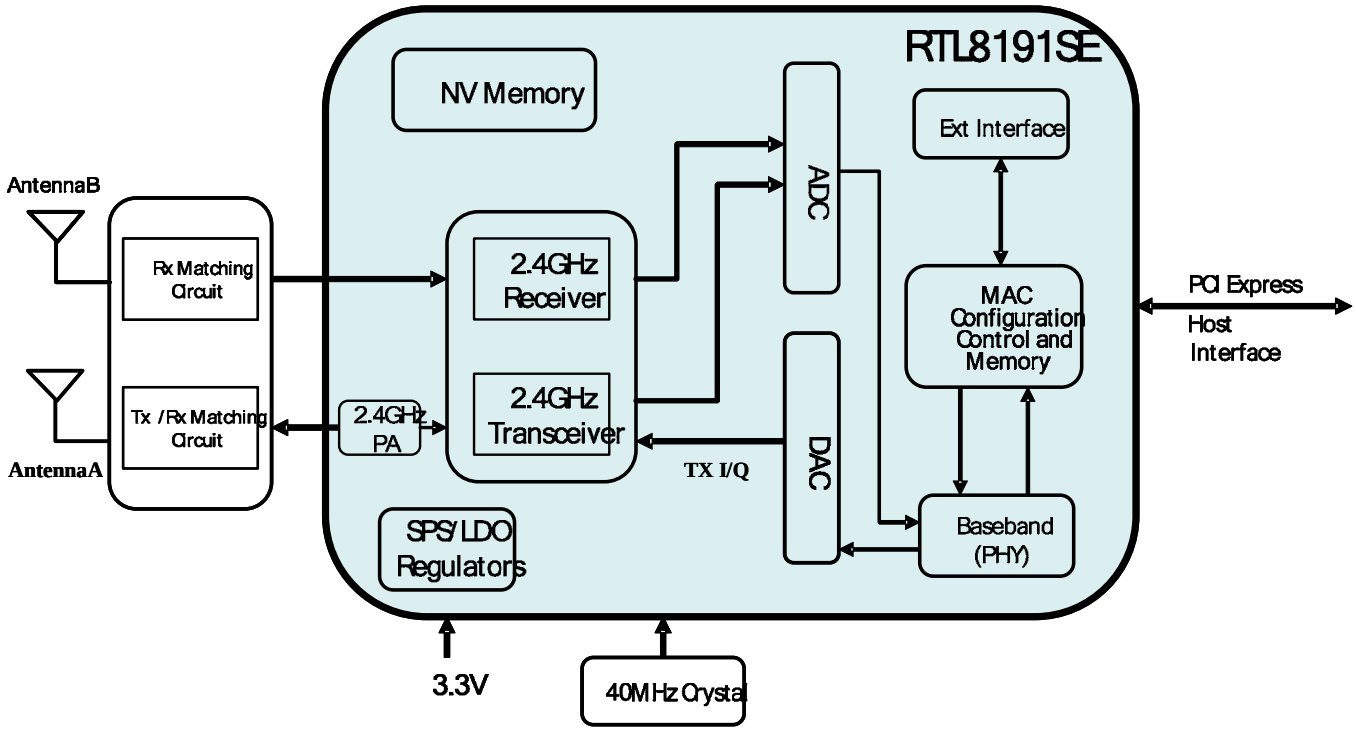


Figure 1. Single Band 11n Application Diagram

4. Pin Assignments

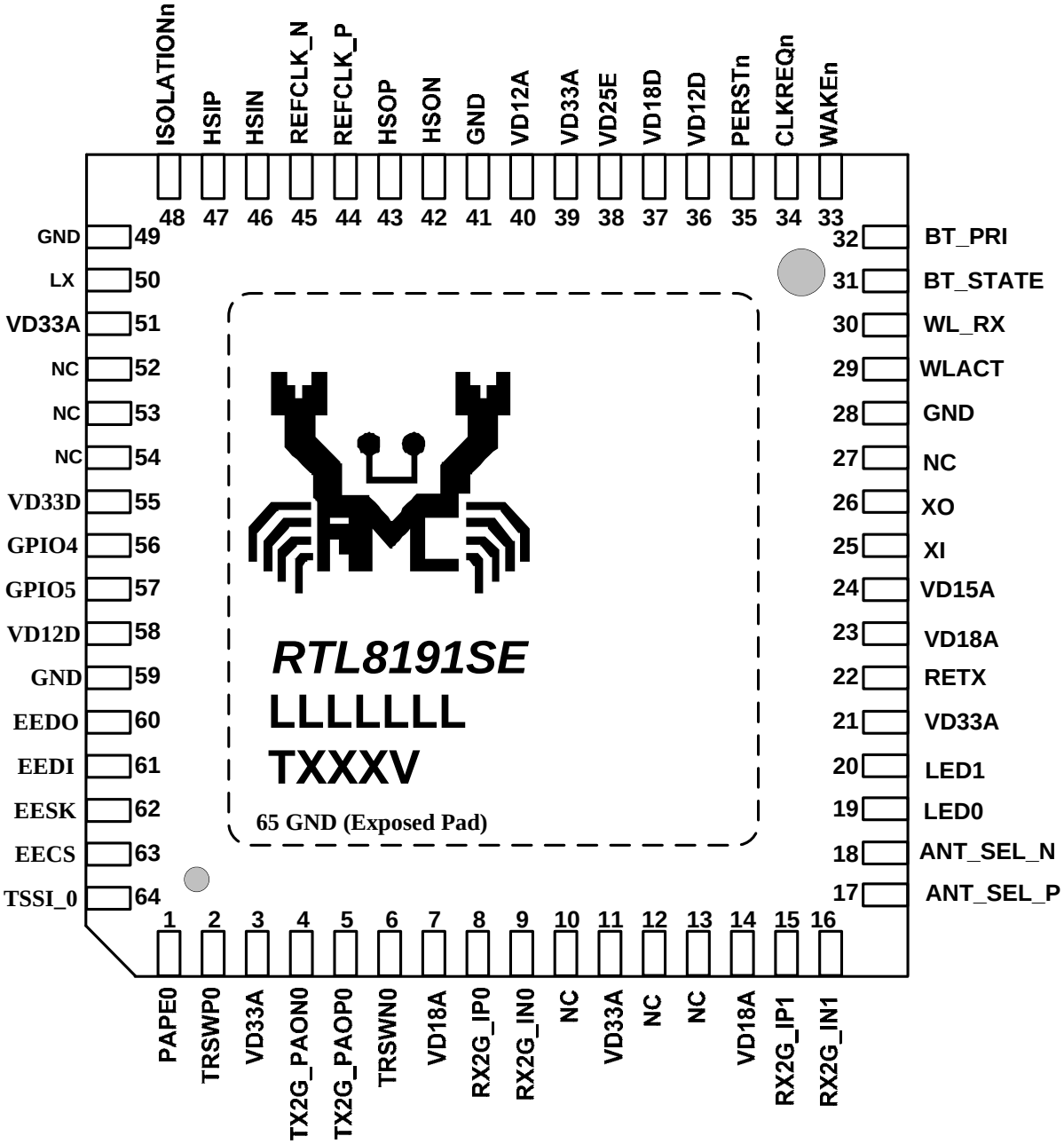


Figure 2. Pin Assignments

5. Pin Descriptions

In order to reduce pin count, and therefore size and cost, some pins have multiple functions. In such cases, the functions are separated with a '/' symbol. Refer to the Pin Assignments diagram on page 10 for a graphical representation.

The following signal type codes are used in the tables:

I: Input.

O: Output

T/S: Tri-State bi-directional input/output pin.

S/T/S: Sustained Tri-State.

O/D: Open Drain.

P: Power pin.

5.1. PCIE Transceiver Interface

Table 1. PCIE Transceiver Interface

Symbol	Type	Pin No	Description
HSIN/HSIP	I	46/47	PCI Express Receive Differential Pair
HSON/HSOP	O	42/43	PCI Express Transmit Differential Pair
REFCLK_P/ REFCLK_N	I	44/45	PCI Express Differential Reference Clock Source: 100MHz ± 300ppm
CLKREQn	O	34	Reference clock request signal. This signal is used by the RTL8191SE-GR to request starting of the PCI Express reference clock
WAKEn	O/D	33	Power Management Event: Open drain, active low. Used to reactivate the PCI Express slot's main power rails and reference clocks.
PERSTn	I	35	PCI Express Reset Signal: Active low. When the PERSTB is asserted at power-on state, the RTL8191SE-GR returns to a pre-defined reset state and is ready for initialization and configuration after the de-assertion of the PERSTB.

5.2. EEPROM Interface

Table 2. EEPROM Interface

Symbol	Type	Pin No	Description
EESK	O	62	EESK in 93C46 programming or auto-load mode.
EEDI	O	61	EEDI in 93C46 programming or auto-load mode.
EEDO	I/O	60	EEDO in 93C46 programming or auto-load mode.
EECS	O	63	EEPROM Chip Select. 93C46 chip select.

5.3. Power Pins

Table 3. Power Pins

Symbol	Type	Pin No	Description
LX	P	50	Input VDD33
GND	P	28,41,59	Regulator GND
VD33A	P	3,11,21,39,51	VDD 3.3V for Analog.
VD12D	P	36, 58	+1.2V (Digital)
VD18A	P	7,15,23	VDD 1.8V for Analog.
VD15A	P	24	Analog 1.5V Capacitor
VD33D	P	55	VDD3.3V for Digital
VD18D	P	37	VDD 1.8V for Digital.
VD12A	P	40	VDD 1.2V for Analog
RETX	P	22	For Bandgap and Bias

5.4. RF Interface

Table 4. RTL8191SE RF Interface

Symbol	Type	Pin No	Description
PAPE0	O	1	2.4GHz Transmit Power Amplifier Power Enable.
TRSWP0	O	2	Transmit/Receive Path Select 0.
TX2G_ON0	O	4	RF TX positive signal to antenna A
TX2G_OP0	O	5	RF TX negative signal to antenna A
TRSWN0	O	6	Transmit/Receive Path Select 0.
RX2G_IP0	O	8	RF RX positive signal from antenna A
RX2G_IN0	O	9	RF RX negative signal from antenna A
PAPE1	O	10	2.4GHz Transmit Power Amplifier Power Enable.
RX2G_IP1	I	15	RF RX positive signal from antenna B
RX2G_IN1	I	16	RF RX negative signal from antenna B
ANT_SEL_P	O	17	Antenna Control Positive signal
ANT_SEL_N	O	18	Antenna Control Negative signal
TSSI_0	I	64	Transmit signal strength indication from external power amplifier

5.5. LED Interface

Table 4. LED Interface

Symbol	Type	Pin No	Description
LED0, 1	O	19/20	LED Pins (Active low).

5.6. Clock and Other Pins

Table 6. Clock and Other Pins

Symbol	Type	Pin No	Description
XI	I	25	40MHz OSC Input. Input of 40MHz Crystal clock reference.
XO	O	26	Output of 40MHz Crystal clock reference.
ISOLATIONn	I	48	This pin can externally shutdown 8191SE without extra power switch. This pin can also support WLAN Radio off function with host interface remaining connected.
VAUXEN/EESK	I	62	Weakly pull high at power on to indicate the presence of the auxiliary power on the mainboard. Otherwise, this is for EEPROM autoload.
GPIO0/WLAN_ACT	I/O	29	There are 8 General Purpose Input/Output pins. Some are used for power-on latch and Bluetooth coexistence, and also EEPROM purposes. The WLAN_ACT signal indicates when WLAN is either transmitting or receiving in the 2.4GHz ISM band.
GPIO1/WLAN_RX	I/O	30	Wireless LAN RX activity indicator.
GPIO2/BT_STATE	I/O	31	The BTSTAT signal indicates when normal Bluetooth packets are being transmitted or received.
GPIO3/BT_PRI	I/O	32	Left not connected if the EEPROM in use is 93C46. The BTPRI signal indicates when a high priority Bluetooth packet is being transmitted or received.
GPIO4	I/O	56	GPIO4.
GPIO5	I/O	57	GPIO5.
GPIO6/EEDO	I/O	60	EEPROM interface EEDO signal.
GPIO7/EEDI	I/O	61	EEPROM interface EEDI signal.

6. Electrical and Thermal Characteristics

6.1. Temperature Limit Ratings

Table 8. Temperature Limit Ratings

Parameter	Minimum	Maximum	Units
Storage Temperature	-55	+125	° C
Ambient Operating Temperature	0	70	° C
Junction Temperature	0	125	° C

6.2. DC Characteristics

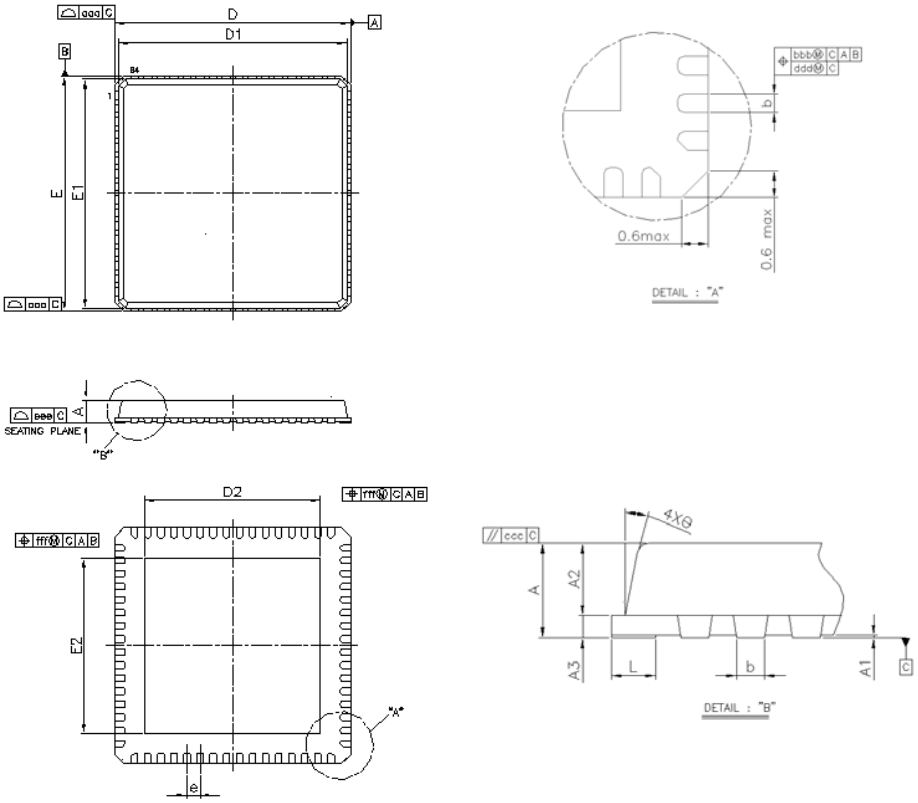
Below is a description of the general DC specifications for the RTL8191SE.

Table 9. DC Characteristics

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
DVDD33	3.3V I/O Supply Voltage		3.135	3.3	3.465	V

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Units
DVDD18	1.8V Supply Voltage		1.71	1.8	1.89	V
DVDD12	1.2V Core Supply Voltage		1.10	1.2	1.32	V

7. Mechanical Dimensions



Symbol	Dimension in mm			Dimension in inch		
	Min	Nom	Max	Min	Nom	Max
A	0.75	0.85	1.00	0.030	0.034	0.039
A1	0.00	0.02	0.05	0.000	0.001	0.002
A2	0.55	0.65	0.80	0.022	0.026	0.032
A_3		0.20 REF			0.008 REF	
b	0.18	0.25	0.30	0.007	0.010	0.012
D/E		9.00BSC			0.354BSC	
D_1/E_1		8.75BSC			0.344BSC	
D2/E2	5.25	5.5	5.75	0.206	0.216	0.226
e		0.50BSC			0.020BSC	
L	0.30	0.40	0.50	0.012	0.016	0.020
θ	0°	—	14°	0°	—	14°
aaa	—	—	0.15	—	—	0.006
bbb	—	—	0.10	—	—	0.004
ccc	—	—	0.10	—	—	0.004
ddd	—	—	0.05	—	—	0.002
eee	—	—	0.08	—	—	0.003
fff	—	—	0.10	—	—	0.004

Notes：

1. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION.
2. CONTROLLING DIMENSION：MILLIMETER(mm).
3. REFERENCE DOCUMENTL：JEDEC MO-220.

8. Ordering Information

Table 8. Ordering Information

Part Number	Package	Status
RTL8191SE-GR	QFN-64, Green package	Enineering Sample

(Blank)

Realtek Semiconductor Corp.
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FCC Statement

Federal Communication Commission Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

For product available in the USA/Canada market, only channel 1~11 can be operated. Selection of other channels is not possible.

This device and its antenna(s) must not be co-located or operation in conjunction with any other antenna or transmitter.

FCC NOTICE: To comply with FCC part 15 rules in the United States, the system must be professionally installed to ensure compliance with the Part 15 certification. It is the responsibility of the operator and professional installer to ensure that only certified systems are deployed in the United States. The use of the system in any other combination (such as co-located antennas transmitting the same information) is expressly forbidden.

IMPORTANT NOTE:

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

USERS MANUAL OF THE END PRODUCT:

In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

The FCC part 15.19 statement below has to also be available in the manual:

This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference and (2) this device must accept any interference received, including interference that may cause undesired operation.

LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " Contains TX FCC ID: TX2-RTL8191SE ".

IC Statement

Country Code Statement
For product available in the USA/Canada market, only channel 1~11 can be operated. Selection of other channels is not possible.

This device and its antenna(s) must not be co-located or operation in conjunction with any other antenna or transmitter.

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p) is not more than that permitted for successful communication.

IMPORTANT NOTE:
IC Radiation Exposure Statement:
This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " Contains TX IC: 6317A-RTL8191SE ".

This module is intended for OEM integrator. The OEM integrator is still responsible for the IC compliance requirement of the end product, which integrates this module.

20cm minimum distance has to be able to be maintained between the antenna and the users for the host this module is integrated into. Under such configuration, the IC RSS-102 radiation exposure limits set forth for an population/uncontrolled environment can be satisfied.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

This Class B digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe B conforme á la norme NMB-003 du Canada.
Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.